New Sight for Old Pipes
Background

2000-2014
The Problem

- $2 million spent on cleaning large lines
- Drawbacks to existing testing methods
- Limited budget for rehabilitation
The Solution: Multi Sensor Inspection
Innovative Technology

HD Camera Module

3D Laser Module

Sonar Module
Inspection Technology

HD CCTV

Sonar

3D Laser
• Determine sources of data (construction files, pipe material standards, staff knowledge)
• Develop data hierarchy flagging
• Confirm connectivity shown in GIS
Discrepancies Found during Research

Original GIS Configuration

Current As-Built Data

Updated GIS Configuration
- GIS Data in Complex Layout was not QC’d previously.
- GIS was modified to represent actual layout.
Data Needs for Multi-Sensor Inspection

- Pipe age
- Pipe material
- Wall thickness
- Number of rows of steel reinforcing
- Placement of steel cage(s)
Determining Remaining Useful Life

- Developed for each concrete pipe wall specification
- Condition score for concrete pipes based on location of steel reinforcement cage
- Developed in AutoCAD to maintain a 1:1 scale

[Image of a chart showing the remaining useful life scoring system for different concrete pipe specifications.]
Remaining Useful Life

- **Inner Pipe Wall**
- **Reinforcement Cages**
- **Outer Pipe Wall**

### 39" Class III, Wall B
- **71-100 years**
- **41-70 years**
- **11-40 years**
- **3-10 years**
- **0-2 years**

### 39" Class III, Wall B w/ Wall A Steel
- **71-100 years**
- **41-70 years**
- **11-40 years**
- **3-10 years**
- **0-2 years**
RUL Calculated Based on Data

Outer Wall

Estimated Original Inner Wall

Measured Inner Wall

1.25" of Pipe Wall Remaining
Remaining Useful Life
Pipe Age vs. Remaining Useful Life

- 71-100 years for 2013 (1921)
- 41-70 years for 2013 (1921)
- 11-40 years for 2012 (1921)
- 3-10 years for 2012 (1921)
- 0-2 years for 1993 (1913)
Case Study: Significant Wall Loss

699.9ft General Observation - Corrosion to 2.6"

730.8ft Point of Interest - Rebar apparent

739ft Maximum Corrosion - To 3.0"

749.9ft General Observation - Corrosion to 2.9"

799.9ft General Observation - Corrosion to 2.3"
Case Study: Structural Failures

387.6ft Point of Interest - Cavity in soffit to 3.9"

380.4ft Point of Interest - Cavity moves into depression within soffit to 6.1"

378ft 3D Laser Scan - Cavity moving into depression visible

350.1ft General Observation - Corrosion to 1.6"

301.4ft Point of Interest - Hole in soffit

301.4ft Point of Interest - Hole in soffit
Case Study: Ovality in Flexible Pipe
Case Study: Ovality in Rigid Pipe
Our Progress – 162 miles (62%)
Benefits of Multi Sensor Inspection

- Reduced capital improvements costs
- Reduced operations and maintenance costs
- Enhanced knowledge of asset status and life cycle
Reduced Capital Improvements

• Restoring capacity through detailed cleaning and debris removal

• Replacing portions of interceptors instead of the whole interceptor
Reduced Capital Improvements

Only 11.7% needed repairs
Identified over $26M in CIP savings

Year 1: $15,728,420
Year 2: $13,430,370
Year 3: $13,998,470
Year 4: $5,562,440

Manhole to manhole replacement cost
Replace only portion in poor condition
Reduced O&M Costs

Reduction in:

• Emergency repairs and reactive maintenance

• Odor control chemicals and facilities

• “Cleaning to inspect” vs. “inspecting to clean”
Line Failure Savings to Date

ICAP Failures to Date (direct)
- Main 253: $487,000 +/-
- Main 244-B: $63,000 +/-
- Main 402-B: $64,000
- Total: $614,000

(Average cost per failure: $204,667)

Segment Failure Savings to Date
$3.15 to $6.30 Million

*Cost Failures Estimated at $50,000 - $100,000 each.*
Reduced Cleaning Costs

$5.89 million saved
Enhanced Knowledge of Assets

- Remaining useful life linked to GIS
- Baseline condition assessment
- Improved hydraulic model
Improved CIP Scheduling
Improved Hydraulic Model

Modeled depth higher than field measurements

### Observations

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Average Debris Depth</td>
<td>2 in</td>
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<tr>
<td>Average Water Level</td>
<td>15 in</td>
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<td>Debris Volume</td>
<td>8 cubic feet</td>
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### Table

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<tr>
<th>MainLat</th>
<th>USSN</th>
<th>DSSN</th>
<th>Dia</th>
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<th>Wall Thickness (in)</th>
<th>Row 1 Steel (in)</th>
<th>Row 2 Steel (in)</th>
<th>Dry Weather Depth (in)</th>
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<td>4.75</td>
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### Inspection Distance (ft)

- **Water Level**:
  - M00257R*: 21.98
  - M00257R*: 24.11
  - M00257R*: 25.31
  - M00257R*: 16.34
  - M00503*: 22.16

- **Debris Level**:
  - M00257R*: 24.68
  - M00257R*: 26.80
  - M00257R*: 27.98
  - M00257R*: 18.89
  - M00503*: 25.27
Lessons Learned

- Data needed for MSI inspection should be maintained for all newly installed pipelines, linked to City geodatabase.

- Supporting data, such as pipe lay sheets, shop drawings, etc. should be stored digitally and with standard naming convention.
Lessons Learned

- City to require submittal of GIS shapefile of completed pipelines and PDF of plans
- Verification of connectivity shown in GIS is essential.
- Age is not an indicator of condition.
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